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19. ABSTRACT (Continue on reverse if necessary and identify by block number) Because all rations envisioned for Army 21 incorporate leading edge technologies, current and anticipated levels of technology in the commercial food industry need to be identified. This report documents a mail survey on food research and development in the commercial food industry. The data collection format selected for use was the mail survey because of the low cost and potential for high response rate. Survey results yielded six major conclusions: (1) food industry research and development budgets are increasing; (2) new product development and new process development remain the thrust behind research and development in the food industry; (3) plastic packaging and aseptic packaging of particulates will play major roles in the food industry during the next 5 to 10 years; (4) major technological breakthroughs are most likely in the areas of					
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flexible packaging and aseptic packaging of particulates; (5) future food products will require only heating to be consumable; and (6) although research efforts in the military and commercial sectors are becoming more similar, important differences remain.

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SUMMARY

In fiscal year 1983, the Directorate for Systems Analysis and Concept Development* at the U.S. Army Natick Research and Development Center** initiated an investigation to determine the combat food service requirements in Army 21. The purpose of this project was to develop an optimal combat food service system concept to help focus future military food service research and development.

This report, the first in a planned series of Army 21 combat feeding reports, documents a survey of commercial food companies and their opinions on current and future research and development efforts in the industry.

Because all rations envisioned for Army 21 incorporate leading edge technologies, current and anticipated levels of technology in the commercial food industry need to be identified. This report documents a mail survey on food research and development in the commercial food industry.

The data collection format selected for use was the mail survey because of the low cost and potential for high response rate.

Survey results yielded six major conclusions: (1) food industry research and development budgets are increasing; (2) new product development and new process development remain the thrust behind research and development in the food industry; (3) plastic packaging and aseptic packaging of particulates will play major roles in the food industry during the next 5 to 10 years; (4) major technological breakthroughs are most likely in the areas of flexible packaging and aseptic packaging of particulates; (5) future food products will require only heating to be consumable; and (6) although research efforts in the military and commercial sectors are becoming more similar, important differences remain.

Based on survey results, the following recommendations are made with regard to DoD food programs.

- Military food research and development budgets must increase to avoid a technology gap with commercial industry.

- Research in the areas of plastic packaging, aseptic packaging of particulates, and irradiation technology should be accelerated to keep pace with industry.

- More emphasis should be placed on the development of shelf stable heat-and-serve items, which require minimum preparation.

*In fiscal year 1986, this element merged with other Natick elements and was renamed the Advanced Systems Concepts Directorate.

**Recently renamed the U.S. Army Natick Research, Development and Engineering Center.

PREFACE

The work described in this report was authorized under the Department of Defense Food and Nutrition Research and Engineering Program, Project 1L162724 A1199, Joint Services Food/Nutrition Technology, Systems Analysis of Combat Food Service Requirements in Army 21. The work was performed from January 1985 to September 1985.

The author is indebted to the following individuals for their contributions to the project: Mr. Joseph Smith, Project Officer, Combat Food Service in Army 21, and Ms. Jane Simpson for their contributions to the design, development, and execution of the survey; and Ms. Maura Severance for her excellent secretarial support throughout the project.

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TRENDS IN FOOD RESEARCH AND DEVELOPMENT: A SURVEY OF THE COMMERCIAL FOOD INDUSTRY

INTRODUCTION

The term Army 21 refers to the Army's warfighting concept for the early 21st century. The purpose of the Army 21 concept is to serve as the basis for evolutionary development in all functional areas, to focus research and development, to establish the framework for future doctrine and force structure, to identify personnel and training imperatives, and to serve as the basic warfighting concept for Army Long Range Planning Guidance (ALRPG).

One of the tasks in the Systems Analysis of Combat Food Service Requirements in Army 21 is to determine the direction of research and development efforts in the food industry in support of this long-range concept.

This report documents the results of a mail survey of commercial food companies. The survey response rate of 68% compared favorably with another survey of many of the same companies by Food Processing Magazine, which resulted in a response rate of only 51%.¹

METHODOLOGY

The survey mailing list was developed using Food Processing magazine's Top 100 list, along with the Research and Development Associates for Military Food and Packaging Systems Industrial Membership Roster. The survey sample included companies representing all of the products classified as food by the Standard Industrial Classification System (SIC) of the Office of Management and Budget. The final mailing list contained the names of 100 food companies, and each received surveys in January 1985.

The mailing package consisted of a cover letter, the survey, and a business reply envelope (see The Appendix). The survey consisted of 2 single-sided pages, contained 5 multiple choice questions, and required respondents to make a total of 28 decisions; 4 demographic questions were also included. Response reminder postcards were mailed during the first week of February 1985, and the first survey returns were received later that week.

Question 1 inquired how will research and development budgets change in the next 5 years. Respondents were instructed to check one of four boxes: increase, decrease, no change, or no research and development funds. A second part of this question asked for possible reasons that would cause shifts in research and development expenditures, such as inflation-induced increases or increases driven by expanding research and development efforts.

Question 2 inquired about the amount of emphasis companies place on each of five typical research and development goals. Respondents were instructed to circle a number from 1 to 5 corresponding to the amount of emphasis their companies placed on each goal, with 1 representing no emphasis and 5 representing very high emphasis. New product development has long been the top priority of research and development in the food industry; however, the consumer market has changed dramatically since the beginning of this decade. This inquiry sought to determine if research and development priorities will change in response to market-based pressure.

A list of eight state-of-the-art technologies in various stages of development throughout the food industry was presented in Question 3. From this list, respondents were instructed to check those technologies that would play a major role in the food industry in the next 5 to 10 years. Respondents could also name a technology not listed on the survey if so desired. Recent developments in packaging, processing, and production technologies have had a dramatic effect on the food industry, and in most cases, these innovations will give way to many offshoot developments. This question sought to identify those technologies that will continue to impact most heavily on the food industry.

Question 4 presented respondents with a list of eight technological areas of the food industry and inquired about the likelihood of major advancements in these areas within 5 years. Respondents were instructed to place an "x" on a line representing a 5-point scale, ranging from very unlikely to very likely. As in Question 3, this question sought to identify the impact of new technologies on the food industry. However, this question focused on advances or breakthroughs most likely to occur in the food industry within 5 years.

Question 5 presented respondents with five statements pertaining to developments in the food industry. Respondents were instructed to circle a number from 1 to 5, corresponding to their level of agreement or disagreement with each statement.

RESULTS AND DISCUSSION

The survey began with four demographic questions inquiring about the company represented, the position or title of the respondent, the primary products of the firm, and the number of employees working for the firm. As shown in Figure 1, nearly 70% of the companies who responded employ more than 500 people, 15% of the companies employ 101-500 people, 12% employ 51 to 100 people, and only 3% of the companies employ fewer than 50 people. These results are in line with current industry trends where there is an increasing concentration of fewer and larger companies.²

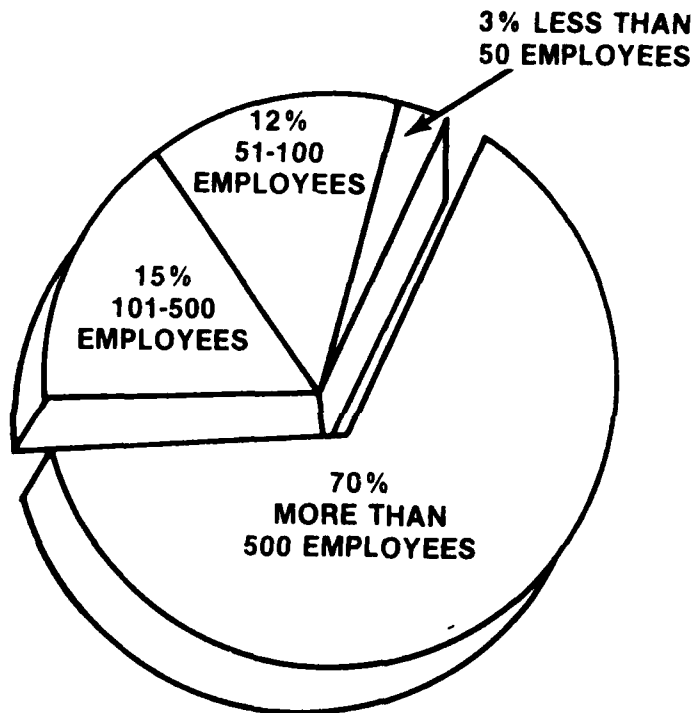


Figure 1. Size of respondents company work force.

The primary products representing the respondents, along with the applicable Standard Industrial Classification (SIC) codes, are presented in Table 1. These percentages sum to over 100% because many of the companies represented have multiple product lines. As the table indicates, the distribution among SIC codes was fairly even.

Research and Development Budget Changes

Approximately 87% of the respondents indicated that their budgets would increase over the next 5 years, while only 7% indicated no change. Another 3% of the sample indicated that their companies had no research and development funds, while only one respondent indicated a decrease in funds. Responses are summarized in Table 2.

TABLE 1. Respondents by Primary Product Classifications.

<u>SIC</u>	<u>Category</u>	<u>Percent Response</u>
201	Meat Products	33.8
202	Dairy Products	19.1
203	Canned & Preserved Fruits & Vegetables	45.6
204	Grain Mill Products	32.4
205	Bakery Products	33.8
206	Sugar & Confectionery Products	32.4
207	Fats & Oils	20.6
208	Beverages	29.4
209	Miscellaneous Food & Kindred Products	57.4
	Other Food Related Products	22.1

TABLE 2. Research and Development Budget Projections.

<u>Projection</u>	<u>Percent Response</u>
Increase	86.7
Decrease	1.5
No Change	7.4
No R&D Funds	2.9
No Response	1.5

A similar question from the Top 100 survey inquired about budget changes for a 1-year period and yielded the following responses: 58% increase, 8% decrease, and 34% no change.³ The time frame of 5 years in the NRDEC survey may account for the higher percentage of increases.

The most frequently cited reason for budget changes, new product development, was selected by 40% of those responding. Business growth and increased emphasis on research and development were each cited as reasons for change by approximately 19% of the sample. All responses are summarized in Table 3.

data for color, reducing capacity, furosine peak areas and fluorescence have been normalized to 1 mg NAL/mL at zero time for comparative purposes.

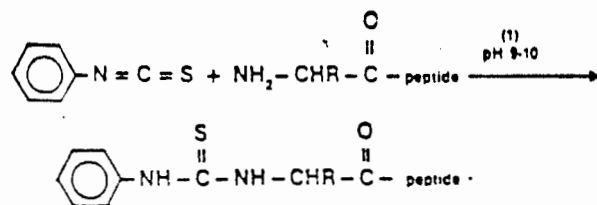


FIGURE 3.: PREPARATION OF PHENYLISOTHIOCARBAMYL (PITC) DERIVATIVES USING PHENYLISOTHIOCYANATE, PEPTIDE (OR AMINO ACID) AND ETHYL ALCOHOL-TRIETHYLAMINE-WATER (pH 9-10).

RESULTS AND DISCUSSION

Reactivity of N- α -Acetyllysine-Glucose-Cellulose (NAL-GL-CE) Models.

The degradation of N- α -acetyllysine (NAL) due to Maillard reaction with glucose (GL) in the acetyllysine-glucose-cellulose (NAL-GL-CE) system at 60°C and $a_w = 0.23$ was followed by monitoring: a) the production of furosine after acid hydrolysis; b) the increase in reducing capacity; c) the formation of fluorescent compounds; d) the increase in brown chromophoric components; e) the loss in NAL; and f) the decrease in GL.

The degradation of NAL and GL suggested an exponential decay, possibly first order kinetics (Figs. 4 and 5). Rate curves exhibiting exponential increases were observed for reducing power and furosine (Figs. 6 and 7). The fluorophoric and chromophoric compounds appeared to increase linearly (Figs. 8 and 9), at least until the end of the present experimental period.

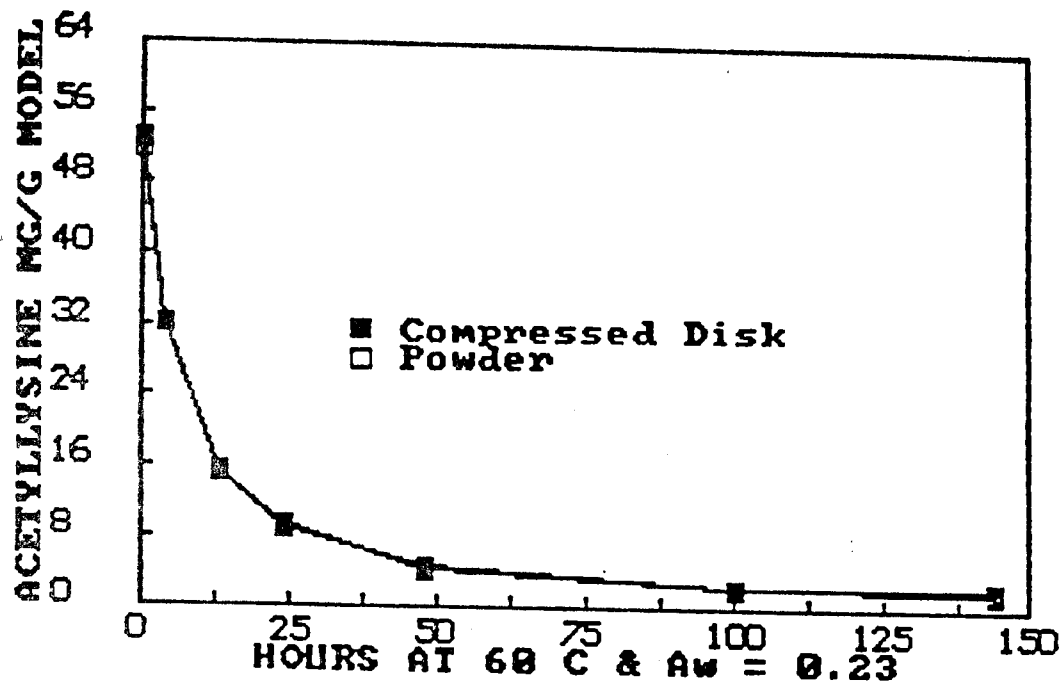


FIGURE 4. DEGRADATION OF ACETYLlysINE IN COMPRESSED AND UNCOMPRESSED ACETYLlysINE-GLUCOSE-CELLULOSE MODELS.

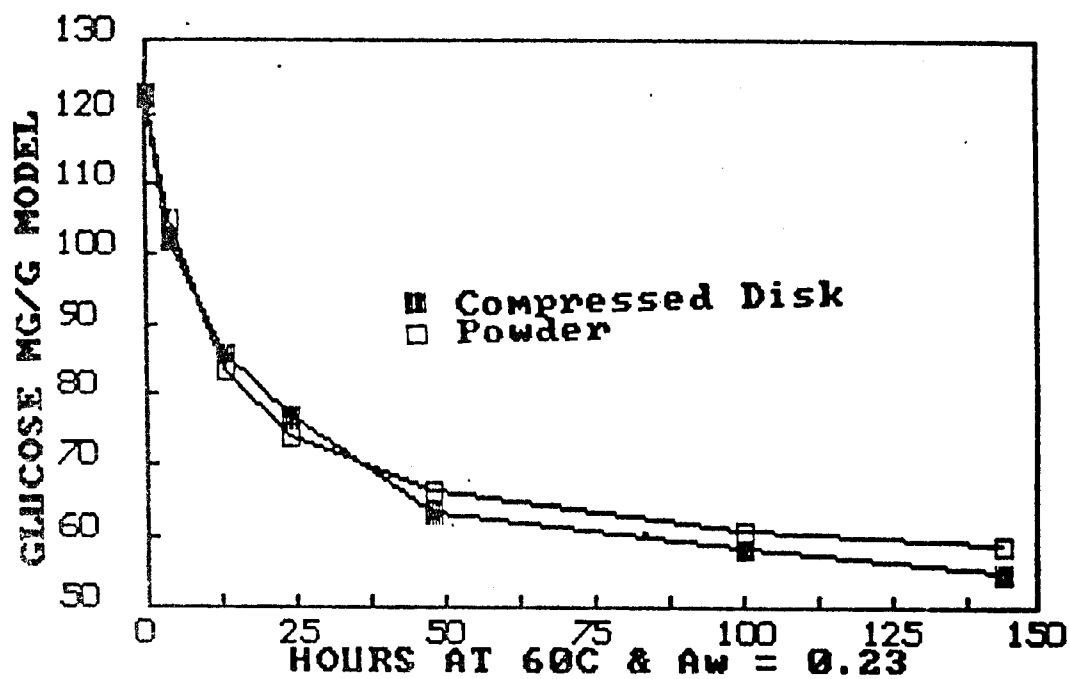


FIGURE 5. DEGRADATION OF GLUCOSE IN COMPRESSED AND UNCOMPRESSED ACETYLlysINE-GLUCOSE-CELLULOSE MODELS.

TABLE 5. Technologies Most Likely to Influence the Industry.

<u>Technology</u>	<u>Percent Response</u>
Plastic Packaging	83.8
Aseptic Packaging of Particulates	76.5
Irradiation Technology	55.9
Genetic Engineering	55.9
Membrane Technology	38.2
Nutrient Preservation	36.8
Encapsulation	23.5
Unconventional Food Sources	8.8
Other Technologies	10.5

Expected Advances in the Food Industry

The fourth question inquired about the likelihood of a major advancement in in eight technological areas of the food industry within the next 5 years. The responses to this question indicated that a major advance in flexible packaging can be expected within 5 years, as nearly 91% of those responding selected a positive response. Nearly 86% of the sample indicated that a major advance was likely in the area of aseptic packaging of particulates. A major advancement in biotechnology is expected by approximately 80% of those responding to the survey. A majority of respondents also indicated that major advances could be expected in genetic engineering, nutrient preservation, and membrane technology. Major advances in irradiation technology and encapsulation are expected by approximately half the sample. Results are summarized in Table 6.

Industry Developments

The following is a summary of responses to Question 5 of the survey.

Future food products will require only heating to be consumable. More respondents, approximately 52%, agreed with this statement than any of the other statements in this question. Several factors are influencing this trend. First, more heat-and-serve items will become available as a result of recent developments in aseptic packaging, retort pouches, and irradiation. Second, the Campbell Soup Company has projected that by 1992, 70% of all women over the age of 16 will be working outside of the home.⁹ Finally, the US Department of Commerce predicts that 50% of American households will have microwave ovens by the end of 1986.¹⁰ All of these developments are increasing the demand for heat-and-serve items.

TABLE 6. Likelihood of Major Technological Advances.

<u>Technology</u>	<u>Very Unlikely %</u>	<u>Somewhat Unlikely %</u>	<u>Not Sure %</u>	<u>Somewhat Likely %</u>	<u>Very Likely %</u>
Irradiation Technology	6.5	29.5	14.1	31.7	18.2
Encapsulation	1.5	12.1	48.5	25.8	12.1
Nutrient Preservation	1.6	9.4	32.8	40.6	15.6
Membrane Technology	0.0	1.6	43.8	26.6	28.0
Flexible Packaging	1.5	1.5	6.1	24.2	66.7
Biotechnology	1.6	3.1	15.6	40.6	39.1
Aseptic Packaging of Particulates	0.0	0.0	14.5	36.0	49.5
Genetic Engineering	1.5	7.6	21.2	36.4	33.3

The market share of frozen foods is expanding most rapidly. Approximately 51% of those responding to the survey agreed with this statement. As stated in the previous paragraph, the market for heat-and-serve items is expanding rapidly and will continue to do so. At the present time, frozen foods dominate the heat-and-serve segment of the food market. Recent advances in ovenable paperboard trays, foil containers, and polyethylene terephthalate (PET) trays promise to expand the market even further. Once again, this growth can be attributed to the increasing number of women working outside of the home and to the increasing number of microwave ovens in American homes.

Irradiation will play a major role in the food industry. Nearly 43% of the sample agreed with this statement. Perhaps this question should also have inquired as to when irradiation will play a major role in the food industry. Present regulations exclude irradiation from just about every food item except potatoes, wheat, wheat flour, and some spices. However, the Food and Drug Administration (FDA) has been petitioned to approve low dose irradiation of hog carcasses and pork products for trichina control, for shelf life extension of refrigerated poultry, and for fruits and vegetables. Industry sources expected approval of these petitions sometime in late 1985 or in early 1986. Even if the FDA loosens regulations, irradiation must still overcome public misconceptions. Unfortunately, most consumers equate a food irradiator with a nuclear reactor. Unless current proponents of irradiation can erase this misconception from the minds of the American people, acceptance of irradiated foods may continue to be elusive.¹¹

The market share of shelf stable food is expanding most rapidly. Due in part to the increased use of aseptic processing and packaging, the market for shelf stable foods has expanded at an astronomical rate since 1981. When the technology for aseptic packaging of low acid foods and particulate-type products reaches full development, the market share of shelf stable products is likely to again experience phenomenal growth.¹² Nearly 40% of those responding to the survey were aware of the dominance of shelf stable products. Despite the current dearth of consumer products, advances in retort pouch technology could affect the market share of shelf stable foods. New, more efficient filling machines could lower costs significantly and allow the retort pouch to shed its military-only image.¹³

A new food preservation technique will dramatically change the industry. Nearly 37% of those responding to the survey did not agree with this statement, while approximately 35% agreed. After years of development, irradiation, the only new food preservation method developed in this century, may be ready to assume a major role in the food industry.¹⁴ Then again, irradiation technology could continue to flounder under the burden of prohibitive regulations. Given this lack of innovation, it would be reasonable to conclude that the food industry will not be dramatically changed by a new preservation technique in the near future.

A response summary is presented below in Table 7.

TABLE 7. Food Statement Evaluations.

Statement	Strongly Disagree %	Somewhat Disagree %	Not Sure %	Somewhat Agree %	Strongly Agree %
The market share of frozen foods is expanding most rapidly	1.5	29.9	17.9	34.3	16.4
Irradiation will play a major role in the food industry	11.7	19.1	26.5	30.9	11.8
Future food products will require only heating to be consumable	4.5	20.9	22.4	35.8	16.4
The market share of shelf stable foods is expanding most rapidly	2.8	41.2	16.2	32.4	7.4
A new food preservation technique will dramatically change the industry	17.6	19.2	27.9	22.1	13.2

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Six major conclusions can be drawn from the results of this survey.

First, food industry research and development budgets are increasing. Nearly 87% of the company representatives responding to the survey indicated that their respective research and development budgets will increase over the next 5 years.

Second, new product development and new process development remain the thrust behind research and development in the food industry, although existing product improvement also receives a great deal of emphasis.

Third, plastic packaging and aseptic packaging of particulates will play major roles in the food industry during the next 5 to 10 years. Irradiation technology and genetic engineering will also become more widely used.

Fourth, the likelihood of a major technological breakthrough is most probable in the areas of flexible packaging and aseptic packaging of particulates.

Fifth, future food products will require only heating to be consumable. The majority of these products will be frozen, although shelf stable items in innovative packages will begin to appear on supermarket shelves.

Sixth, although research efforts in the military and commercial sectors are becoming more similar, important differences remain. Both sectors are seeking to develop products incorporating recent packaging innovations. These efforts differ on the issue of stability. The military is seeking to develop better shelf stable items, while industry is seeking to develop better frozen products.

Recommendations

Based on survey results, the following recommendations are made with regard to DoD food programs.

- Military food research and development budgets must increase to avoid a technology gap with commercial industry.
- Research in the areas of plastic packaging, aseptic packaging of particulates, and irradiation technology should be accelerated to keep pace with industry.
- More emphasis should be placed on the development of shelf stable heat-and-serve items, which require minimum preparation.

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APPENDIX: Survey Materials



DEPARTMENT OF THE ARMY

US ARMY NATICK RESEARCH and DEVELOPMENT ~~LABORATORIES~~ Center
NATICK, MASSACHUSETTS 01760 - 5015

January 21, 1985

REPLY TO
ATTENTION OF:

Directorate for Systems Analysis
and Concept Development

Dear Food Industry Colleague:

With the development of the US Army's battlefield plans for the 21st century underway, the US Army Natick Research and Development Center has been tasked to conceptualize and develop an optimal foodservice system for future forces. One important aspect of this task is to determine the direction of future research and development in the commercial sector of the food industry, both long and short term.

As a representative of a leading food company, your completion of the attached survey will help us to develop a composite of current and projected research and development efforts of companies like your own. Since only one hundred surveys will be mailed, your response is critical to the success of this project. The survey will only require a few moments of your time.

Your reply to this survey will be held in strict confidence, only statistical summaries will be released. Thank you for supporting our efforts to maximize the utility of every federal research dollar in developing a ration system for tomorrow's soldier.

Sincerely,

Philip Brandler
Director of Systems Analysis
and Concept Development

1 Atch
as

Survey Cover Letter

FOOD INDUSTRY SURVEY

Company _____ Position/Title _____

Primary Products _____

Number of Employees: Under 50 ☐ 51-100 ☐ 101-500 ☐ Over 500 ☐

1. How will your company's research and development budget change in the next five years ? PLEASE CHECK THE APPROPRIATE BOX.

Increase ☐ Decrease ☐ No Change ☐ No R&D Funds ☐

Reason for change _____

2. How much emphasis does your company place on each of the following R&D goals ? PLEASE CIRCLE A NUMBER FROM ONE TO FIVE FOR EACH AREA.

	No Emphasis	Low Emphasis	Moderate Emphasis	High Emphasis	Very High Emphasis
New Product Development	1	2	3	4	5
New Process Development	1	2	3	4	5
Improve Existing Products	1	2	3	4	5
Explore New Technologies	1	2	3	4	5
Increase Productivity	1	2	3	4	5

3. Which of the following state of the art technologies do you think will play a major role in the food industry during the next five to ten years ?

PLEASE CHECK ALL THAT APPLY.

Genetic Engineering	<input type="checkbox"/>	Unconventional Food Sources	<input type="checkbox"/>
Irradiation Technology	<input type="checkbox"/>	Nutrient Preservation	<input type="checkbox"/>
Plastic Packaging	<input type="checkbox"/>	Aseptic Packaging of Particulates	<input type="checkbox"/>
Membrane Technology	<input type="checkbox"/>	Encapsulation	<input type="checkbox"/>
Other	<input type="checkbox"/>	_____	

4. Please place an "X" on each line corresponding to the likelihood of major technological advancements within five years for the following areas:

	Very Unlikely	Somewhat Unlikely	Not Sure	Somewhat Likely	Very Likely
Irradiation Technology					
Encapsulation					
Nutrient Preservation					
Membrane Technology					
Flexible Packaging					
Biotechnology					
Aseptic Packaging of Particulates					
Genetic Engineering					

5. For each of the following statements, please circle a number from one to five corresponding to your level of agreement for each statement.

	Strongly Disagree	Somewhat Disagree	Not Sure	Somewhat Agree	Strongly Agree
The market share of frozen foods is expanding most rapidly	1	2	3	4	5
Irradiation will play a major role in the food industry	1	2	3	4	5
Future food products will require only heating to be consumable	1	2	3	4	5
The market share of shelf stable foods is expanding most rapidly	1	2	3	4	5
A new food preservation technique will dramatically change the industry	1	2	3	4	5

THANK YOU FOR COMPLETING THIS SURVEY. A POSTAGE PAID RETURN ENVELOPE HAS BEEN INCLUDED FOR YOUR CONVENIENCE. IF YOU WOULD LIKE TO PARTICIPATE IN A FOLLOW-UP SURVEY, PLEASE WRITE YOUR NAME, ADDRESS, AND TELEPHONE NUMBER IN THE SPACE BELOW. WE WELCOME YOUR COMMENTS ON THE SURVEY OR THE SURVEY SUBJECT MATTER.

DEPARTMENT OF THE ARMY
US ARMY NATICK R&D LABORATORIES
NATICK, MA 01760

Just a Reminder:

Approximately one week ago, we mailed you a survey on food research & development. If you have not already done so we ask you to take a few minutes to complete the survey and mail it back to us. Your response is critical to the success of our project. If you have misplaced, or never received a copy of the survey and would like to participate, please call AC 617-651-4252 during business hours.

Thank you for your cooperation.
Combat Food Service Division
DSACD
US Army Natick R&D Center

Response Reminder Postcard